

application, included such an Abstract. In the event that the Abstract is deemed insufficient, Applicant has attached hereto, as Attachment A, an Abstract of the Disclosure. Reconsideration and withdrawal of the objection to the specification is respectfully requested.

Claims 1-20 have been rejected under 35 USC §103(a) as being obvious in view of certain information disclosed in Volume 2 of the ASM Handbook directed to aluminum alloys having the designations 356.0 and 357.0. This rejection is respectfully traversed. It is asserted, in making the rejection, that aluminum alloy 356.0 has a composition which overlaps that of Claims 1, 4, 5 and 15, and that substantially the same process steps as are recited in Claims 12, 13, 14, 19 and 20 are disclosed for use with the 356.0 alloy. The alloy 357.0 is cited as overlapping or touching the boundary of the recited claim limitations, and as disclosing substantially the same process steps as claimed.

It is acknowledged in the Official Action that the cited excerpts of the ASM Handbook do not teach the solidification rate for the casting, nor do they identify what phases are present in the microstructure. Nonetheless, it is asserted that it would have been obvious to use an intermediate to high solidification rate for the 356.0 and 357.0 alloys, in order to produce a high quality casting with small dendrite arm spacing.

It is further acknowledged in the Official Action that the ASM Handbook does not disclose what phases are present in the final and intermediate alloys of 356.0 and 357.0. Citing to a specific example given in Applicant's specification, it is asserted that a substantially similar solution treatment is disclosed in the prior art. The conclusion as to obviousness is reached using the reasoning that, because "the prior art discloses substantially the same aluminum alloy processed in

substantially the same steps, substantially the same product would result as presently claimed”.

Applicant, for its part, acknowledges that the nominal composition of at least the 357.0 alloy disclosed in the ASM Handbook overlaps or touches upon the compositions set forth in independent Claims 1 and 5 and certain other of the claims. Applicant wishes to emphasize that the invention is not principally directed to the claimed composition, but rather to obtaining the claimed microstructure in the claimed composition. This is clearly evidenced by the fact that, in the specification, Applicant has acknowledged the existence of certain alloys registered in Australia which have compositions which bear some resemblance the claimed compositions. The present invention marks a departure from those known registered alloys, in processing the alloys in a manner such that the iron-containing phases(s) in the matrix are solely or predominantly a  $\beta$  phase that is a transformation product of the  $\pi$  phase.

By way of further background, as is noted in the specification beginning at page 3 thereof, iron is present in these alloys as an impurity, and indeed is the main impurity. In higher Mg content alloys of this type, the  $\pi$  phase ( $\text{Al}_8\text{Si}_6\text{Mg}_3\text{Fe}$ ) is the predominant phase formed, whereas, in low magnesium content alloys of this type, the  $\beta$  phase ( $\text{Al}_5\text{SiFe}$ ) will be the predominant phase. Both phases are detrimental to mechanical properties.

In the high Mg content alloys in which the  $\pi$  phase is the predominant iron-containing phase, approaches have been proposed in the prior art to eliminate, to the extent possible, the  $\pi$  phase, in order to eliminate or reduce its detrimental impact on mechanical properties. One approach has been to add beryllium so that a  $\text{BeSiFe}_2\text{Al}_8$  phase will form preferentially to the  $\pi$  phase. This leads to improved

mechanical properties. The use of beryllium, however, is seen as creating serious health hazards. Manganese (Mn) has also been used in attempts to modify the iron-containing phases in these alloys. Nonetheless, the deleterious effect of the  $\pi$  phase on alloy quality persists to this day.

In a departure from prior art attempts to contend with the presence of the  $\pi$  phase, the present invention is directed to eliminating or reducing the presence of the  $\pi$  phase, by processing the alloy so as to obtain the  $\beta$  phase as a transformation product of the  $\pi$  phase, such that the  $\beta$  phase is the sole or predominant iron-containing phase present. This has been seen as leading to improved alloy quality by reducing brittleness or increasing the ductility of the cast alloy. Further, the reduction in the  $\pi$  phase results in higher levels of Mg in solution which is available for precipitation during aging to improve the strength of the alloy.

The cited excerpts from the ASM Handbook do not disclose an alloy as defined in independent Claim 1, in which the sole or predominant iron-containing phase in the alloy is the  $\beta$  phase that forms as a transformation product of the  $\pi$  phase. The cited excerpts further do not disclose step (c) of the method defined in independent method Claim 5 in the present application. This step requires that the casting produced in step (b) be solution heat treated to at least partially transform the  $\pi$  phase to the  $\beta$  phase.

The Official Action tacitly acknowledges that these claimed features are not explicitly disclosed in the excerpts, in that the claims have not been rejected as having been anticipated by that disclosure. The Official Action correctly makes no attempt to apply the principle of anticipation by inherent disclosure of these claim limitations, as the disclosure in the ASM Handbook clearly does not rise to the level

of establishing, to a certainty, that the products made from the 356.0 and 357.0 alloys have solely or predominantly the  $\beta$  phase and not the  $\pi$  phase as the iron-containing phase. Ex parte Skinner, 2 USPQ2d 1788 (PTO Bd. App. & Int. 1986) (inherency may not be established by probabilities or possibilities).

Turning to the alleged obviousness of the invention set forth in the claims, it is important to note that there is no discussion in the ASM Handbook regarding the presence of, or relative merits of, the  $\pi$  phase and/or the  $\beta$  phase. As such, it is by no means apparent why a person skilled in the art, on reading the excerpts from the ASM Handbook, would choose to set out to form the 356.0 and 357.0 alloys in a manner such that the sole or predominant iron-containing phase is  $\beta$  phase which forms as a transformation product of the  $\pi$  phase. It is only the present specification that provides this motivation or suggestion.

The rejection, understandably, attempts to provide the "missing link" between the prior art and the claimed invention. It is asserted that the phases present in the 356.0 and 357.0 alloys will be the same as, or will be substantially the same as, those claimed, because the solution treatment used as an illustration in the present specification (page 8, lines 13-15) is asserted to be substantially the same as the solution heat treatment as is disclosed in the prior art. This link, however cannot legitimately be made.

Looking first to the 356.0 alloy (and/or the A356.0 alloy), the composition set forth in the ASM Handbook subsumes, with one exception (Mg), the composition of the claimed alloy, as well as a large range of alloy compositions that would not fall within the scope of Claim 1 of the instant application. The magnesium content for the 356.0 alloy also differs from that of Claim 1, although there is a degree of overlap.

Applicant here has discovered that an aluminum-based alloy (aluminum-silicon-magnesium) having improved mechanical properties can be produced by restricting the alloy composition to the claimed range, and by ensuring that the sole or predominant iron-containing phase is the  $\beta$  phase which is formed as a transformation product of the  $\pi$  phase. As noted previously, the cited excerpts from the ASM Handbook are completely silent with respect to the presence or absence of the iron-containing  $\pi$  phase in the castings, and with respect to the presence of, or desirability of the presence of the  $\beta$  phase (as compared with the presence of  $\pi$  phase) as the predominant iron-containing phase.

Nothing about the disclosure of the 356.0 or the A356.0 alloy in the ASM Handbook leads the person skilled in the art to the present invention. The disclosure of the 356.0 alloy in the ASM Handbook does not suggest in any way limiting the range of the various elements to those set forth in Claims 1 and 5, for the purposes of improving mechanical properties, or for the purpose of providing a composition in which an iron containing  $\pi$  phase would be transformed into the  $\beta$  phase, in improving the mechanical properties. As such, Claims 1 and 5 are clearly not rendered obvious by the disclosure in the ASM Handbook of 356.0 alloy.

Similarly, the disclosure of the 357.0 and A357.0 alloys in the ASM Handbook does not provide persons of ordinary skill in the art with an understanding of the underpinnings of the present invention. As such, the invention cannot be said to be rendered obvious by that disclosure.

In the course of arriving at the present invention, the inventors determined that the mechanical properties of Al-Si-Mg foundry alloys having compositions falling within the claimed range are improved by producing products made of the alloy to have the  $\beta$  phase be the predominant iron-containing phase in the

alloy, and not the  $\pi$  phase. Previously, it had been understood that the  $\pi$  phase was the predominant iron-containing phase in alloys of this type having higher Mg contents. (Specification, p. 3) In similar alloys with lower Mg contents, the  $\beta$  phase would form as the predominant iron-containing phase (Specification, p. 3). In each of these groups of alloys, the  $\pi$  phase and the  $\beta$  phase were both seen as being detrimental to the physical or mechanical properties of products cast with these compositions.

As further noted in the specification, attempts to eliminate or reduce the presence of the  $\pi$  phase in the higher Mg content alloys focused on chemistry control to form iron-containing phases other than the  $\pi$  phase. The example cited in the specification, at page 4 thereof, was that of including beryllium in such alloys, in order that a  $\text{BeSiFe}_2\text{Al}_8$  phase would precipitate preferentially to the  $\pi$  phase, taking the impurity iron into that phase. Indeed, this appears to have been how the developers of the A357.0 alloy addressed problems with physical and mechanical properties of the 357.0 alloy, in that the A357.0 alloy includes beryllium.

Only in the present specification is it disclosed that the mechanical properties of alloys falling within the claimed composition ranges could be improved by producing the alloy so as to have the  $\beta$  phase, which, as noted previously, was regarded as an undesirable and detrimental phase in its own right, be the predominant iron-containing phase in the alloy.

The Official Action cites to Applicant's disclosure (specification, p. 8) of an example of a casting having an Mg concentration of 0.5 wt.%, and using a solution treatment at 540°C. for 2 or more hours, to produce a desired level of transformation of  $\pi$  phase to  $\beta$  phase. This disclosure is then compared to the

disclosure, in the ASM Handbook, of using a solution treatment of 540°C. for 8 hours, followed by hot water quench and aging. The Official Action concludes that the prior art thus discloses substantially the same aluminum alloy processed in substantially the same steps, resulting in substantially the same product, and asserts that this establishes a prima facie case of obviousness.

The present specification (page 8) notes, however, that the selection of the temperature and time required for the solution treatment of the alloys disclosed therein will depend upon variables such as the concentration of magnesium and other elements in the casting. Thus, it is not proper to cite to the specific example given in arriving at the conclusion that a prima facie case of obviousness exists. The prior art does not appear to recognize nor appreciate Applicant's approach to improving the mechanical properties of the claimed Al-Si-Mg alloy compositions. As such, Applicant's solution to the problem would not have occurred to persons skilled in the art. If now being given the benefit of Applicant's solution, i.e., to form the castings with the  $\beta$  phase as a transformation product of the  $\pi$  phase as the predominant iron-containing phase, persons of ordinary skill in the art would understand or readily determine the times and temperatures required in order to achieve the desired microstructural change.

It is indeed within the realm of possibilities that castings of certain alloy compositions falling within the 357.0 specification ranges, when solution treated at 540° for 8 hours, would end up having the  $\beta$  phase as the predominant iron-containing phase. However, this possibility does not render the present invention obvious. If nothing else, as seen in the specific example given at page 8 of the specification, the recognition by the present inventors that improved mechanical properties would be realized by transforming the  $\pi$  phase to predominantly the  $\beta$

phase, allowed for a solution treatment of only two hours in duration, thus avoiding the "standard protocol" for the 357.0 alloy, which dictates an eight (8) hour hold at the solution treatment temperature. It can thus be seen that the recognition that the  $\pi$  phase transformation as the key to improving mechanical properties permits those skilled in the art to deviate from the "one size fits all" solution treatment set forth in the 357.0/A357.0 specification. The alloys of the present invention are thus not processed in "substantially the same steps" as are the 357.0/A357.0 alloy disclosed in the ASM Handbook.

The 357.0 alloy is also not "substantially the same aluminum alloy" as the alloy set forth in Claims 1 and 5 herein. Notwithstanding that there is a degree of overlap in the magnesium contents (0.35-0.50 in claims 0.45-0.60 in 357.0 alloy), clearly the 357.0 alloy falls into the category of alloys which, as noted in the specification (page 3), as the magnesium content of the alloy increases, the magnesium content of the  $\pi$  phase may change, leading to even greater volume fractions of the phase for a given Fe content. Thus, for a large portion of the alloy compositions within the 357.0 specification, it may be the case that the solution treatment may not result in a predominant  $\beta$  phase, not that there is any evidence that this had been a consideration prior to the present invention. Indeed, the fact that the A357.0 variant of 357.0 contains beryllium evidences that chemistry control to produce a phase other than  $\pi$  or  $\beta$  is used for this alloy where excessive brittleness or lower strengths were sought to be eliminated.

Persons of ordinary skill in the art would thus not view the 357.0/A357.0 alloy and the alloy of the present invention, with its specifically recited microstructure, as being substantially the same alloy. Accordingly, it has been incorrectly concluded that a prima facie case of obviousness is established by the

ASM Handbook. Reconsideration and withdrawal of the rejection of Claims 1-20 in view of the excerpts from the ASM Handbook is thus respectfully requested.

Claims 1-20 have also been rejected under either of JA53-16312 or GB595,531, in view of the excerpts from the ASM Handbook discussed above. This rejection is also respectfully traversed.

The two different combinations will be discussed separately following this paragraph. As to each of the references cited in combination with the ASM Handbook, Applicant notes that neither of these references adds anything to the teachings of the ASM Handbook itself, which as noted above, does not establish a prima facie case of obviousness as to these claims. The Official Action notes that the Japanese and Great Britain references, "do not teach the solidification rate of the casting or what phases are present" in the end product. These are precisely the shortcomings noted with respect to the ASM Handbook excerpts. As such, all three references share the same deficiencies, the most notable of which is the fact that none addresses the use of microstructure modification of the iron-containing phase to improve the mechanical properties of the alloy.

The examples given in the English language abstract of JP 53-16312 have compositions which fall outside the ranges set forth in the claims of the present application. Specifically, the Mg content of 0.3 wt.% in those examples falls outside the claimed range. The more broadly stated range of compositions does provide a small overlap in magnesium composition. However, given that the transformation of  $\pi$  phase to  $\beta$  phase is dependent upon composition as well as other parameters, the broad-brush disclosure in the abstract of JP53-16312, whether or not taken in combination with the ASM Handbook excerpts, does not disclose or suggest

producing an alloy of the claimed composition in which the predominant iron-containing phase is the  $\beta$  phase as transformed from the  $\pi$  phase.

Turning to the Great Britain reference, it is noted that the alloys disclosed therein clearly do not disclose "substantially the same alloy" as is claimed in the instant claims. The Great Britain reference discloses alloys having chromium and cobalt, as well as possibly manganese, in concentrations far in excess of the amounts allowed by the claims under examination. In these claims, chromium and cobalt would be regarded as impurities which are to be limited each to 0.05 wt.%, and 0.15% wt.% in the aggregate. Manganese is limited to less than 0.05 wt.%, as well. In the Great Britain reference, a combination of two or three of these three elements must be present, in a range of 0.50-0.80 wt.%. In the specific example given, the manganese level clearly exceeds that permitted by the instant claims, and the combination of chromium and cobalt adds to 0.23 wt.%, well in excess of the maximum impurity level permitted by the claims.


Accordingly, it is respectfully submitted that the Great Britain reference does not disclose "substantially the same alloy" as is claimed. The Great Britain reference, as acknowledged in the Official Action, is further silent as to the claimed microstructure. Thus, the Great Britain reference, whether or not used in combination with the excerpts from the ASM Handbook, falls well short of rendering obvious the present invention. Reconsideration and withdrawal of the rejections of Claims 1-20 under 35 USC §103, in view of either the Japanese or Great Britain references, in view of the ASM Handbook, is respectfully requested.

In view of the foregoing, Applicant believes that all claims as currently presented are in condition for allowance. Reconsideration and withdrawal of all rejections, and passage of the application to issue at an early date, are earnestly

solicited. The Examiner is encouraged to call the undersigned should there be any remaining issues that can be resolved in a telephone conference.

Respectfully,

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